ECE 4624

Electronic preparation of your solution is mandatory, with each step in a separate page. Due date after two weeks, Due date: **April 6, 2006**

Part one:

1. Start with the Gain (K), zeros (Z) and poles (P) of an analog lowpass filter,
   K = 0.0032, Z = ± 1.0824i, ±2.6131i, P = -0.1385 ± 0.3622i, -0.3743 ± 0.1679i.
   Plot the frequency response of this analog filter. Write down the transfer function in the frequency domain.

2. What kind of filter is this? Determine the passband ripple (linear and dB), passband cutoff frequency, stopband ripple (linear and dB), and stopband cutoff frequency. (Note that: either the cutoff for the passband or the stopband should be 1 rad/s for the prototype filter)

3. Implement and use the parametric BT to find the poles and zeros of a digital filter and determine to which frequency the analog stopband frequency has mapped.

4. Use the LP to BP Spectral Transformation (ST), with parameters $\alpha = 0.5$ and $\beta=1$ and plot the ST frequency warp that will be in effect. Indicate the correspondence of cutoff frequencies before and after the ST.

5. Find the poles and zeros of the digital bandpass filter. Put the poles and zeros into real SOS, and evaluate the frequency response of the resulting bandpass filter.

Use the above process, together with analog poles and zeros provided by the Matlab routines buttap, cheb1ap, cheb2ap, or ellipap, to design a digital bandpass filter. Keep in mind that we like our filter to be computationally efficient.

Now you are ready to proceed with the design process that should lead to a digital filter that meets the specifications given below.

Part two:

SPECIFICATIONS (all digital domain frequencies are fractional frequencies).
Passband ripple: ±0.008 (note that: this is linear scale)
Lower and upper passband cutoff frequencies: 0.17 and 0.31
Stopband ripple: −56 dB
Lower stopband and upper stopband cutoff frequencies: 0.0625 and 0.42.

6. Our next goal is to design a digital filter that meets (or exceeds) given specifications. In preparation for the design, you first implement and investigate steps of the forward design path/process – from analog poles and zeros to a digital bandpass filter – in some detail, as outlined in items 1 through 5. (repeat steps 1 to 5 to end up with the desired BP filter)

7. Design the desired filter using Matlab and compare your results with what you got analytical design. You may use the FVTOOL command for evaluation of the specifications, zooming in where necessary. Document the steps in the process.